OBJECTIVES

Upon completion of this module, without using reference material, the student will be able to:

1. Select the definition of an “additive.”
2. Select the 4 requirements for the acceptance of an additive.
3. Identify the location in the establishment where additives must be received.
4. Select the two types of letters of guaranty for nonmeat and nonpoultry items.
5. Select the items that must appear on the label of any additive that is brought into the establishment.
6. Select the requirements for packaging materials entering the official establishment.
7. Select, from a list, how additives are examined to determine if they are acceptable.
8. List three methods used to measure water added to product, and identify who is responsible for checking the accuracy of the method(s) used to measure the water.
9. List at least 3 benefits from using water in the preparation of meat or poultry products.
10. List the requirements for identifying restricted ingredients if the plant is mixing its own additives.
11. Given the following classes of additives:

    a. Antioxidants

    b. Binders/Extenders

    c. Cure accelerators

    d. Curing agents

    e. Flavoring agents

    Select/Identify:

    (1) The purpose of each class of additive.

    (2) Several products that can contain each class of additive.

    (3) The maximum amount of each class of additive allowed in a specific product.

    (4) The portion of the product formula on which the maximum amount is based.

12. From a sample problem, calculate to determine compliance for:

    a. An antioxidant compound, when added to lard, rendered animal fat, and animal or animal/vegetable fats.

    b. An antioxidant or antioxidant compound, when added to fresh sausage or other fresh product.

13. Given sample problems, calculate the maximum amount of a cure agent, cure compound, and cure accelerators allowed in a product formula.
14. Given sample problems, calculate the in-going parts per million of a cure agent and cure accelerator used in a product formula.

INTRODUCTION

The definition of an additive is “any safe ingredient added to a meat or poultry product other than meat, poultry, or meat and poultry byproducts for a specific purpose.”

When there is a proposal by the industry to include any additive in the manufacturing of a meat or poultry product, the additive must

- be safe.
- not detract from the product or promote deception.
- serve a useful purpose or benefit the consumer.
- lend itself to inspectional and/or analytical control.

The burden of proof that a proposed additive meets the criteria is upon the industry and the plant must furnish a procedure for control.

After an additive has been accepted it may be necessary to limit its use to certain products and/or amounts to comply with criteria.

In the meat and poultry industry, water is the most common additive used in product preparation. In applying the first acceptance criterion stated above, we consider water to be generally recognized as safe.

In order to prevent water from *detracting* from the product or *promoting deception*, its use is limited in the preparation of some products. In cooked sausage, except for those that fall under the fat and added water requirements, water is limited to 10 percent of the finished product. In fresh sausage, water is limited to 3 percent of the total ingredients.

Next, water serves a *useful purpose* and *benefits the consumer*. These benefits are that water

- (or ice) *controls the temperature during preparation* and prevents “fatting out” of the product during the cooking process.
- *facilitates stuffing* by allowing a more uniform stuffing operation and reducing the occurrence of voids or pockets in the casing.
- *aids in mixing the additives,* thus they are more uniformly distributed in the finished product.
- *improves the texture* of the finished product.
- *improves the yield* by replacing the natural moisture lost during processing and allowing the product to be formulated to contain amounts of added water in the finished product as specified in the regulations.

Finally water lends itself to *inspectional* and *analytical* control. A sample of the finished product with a water limitation may be selected and sent to a laboratory for analysis. Water is controlled inspectionally by requiring a formula indicating the amount of water used in the preparation of each product. Water must always be added in *measured* amounts. It may be measured by a meter, scale, or by volume. It is the responsibility of the establishment to verify the accuracy of the measuring device as often as necessary.

RECEIVING REQUIREMENTS

When nonmeat and nonpoultry items (other than water and ice) are brought into the plant, they should be enclosed in sanitary containers and received at a designated area. The labeling requirement would include

- The name of the product.
- A list of the ingredients, if it is composed of two or more ingredients.
- The amount or percentage of each restricted ingredient. (An additive is limited to the amount allowed.)
- The name and address of the manufacturer, or other qualifying phrase such as "manufactured for," "packed for," or "distributed by."

When *curing agents, nitrites, and nitrates are* brought into a plant, they *may* be mixed with salt, sugar, corn syrup solids, or monosodium glutamate. When curing agents are mixed with these ingredients, the result is commonly referred to as a cure mix or curing compound. When curing compounds are received, they must have the *percentage of nitrite and/or nitrate* indicated on the container.

The manufacturers of *curing compounds* may tint their products with FD&C Red #3 dye as an aid to easy identification. Each 100 pounds of tinted compound may contain up to 0.45 *grams* of FD&C Red #3 and not less than *3 pounds of nitrite.* These compounds must be labeled to identify FD&C Red #3; however, no reference to the coloring is needed when the compound is added to a meat or poultry product. This small amount would not add coloring.

If curing agents are received with other mixtures of ingredients (other than salt, sugar, corn syrup solids, or monosodium glutamate) they must be in a separate and distinctly identified package.

When proteinaceous additives that are classified as Group 2 protein-contributing ingredients in §318.22 of the MPI regulations will be used in the preparation of cooked sausages as described in §319.140 and §319.180-§319.182 of the MPI regulations are brought into the establishment, plant management must provide the program employee with information stating the protein content of each Group 2 ingredient. This information may be obtained by laboratory analysis of Group 2 ingredients or by certification and/or declaration on the labels of the Group 2 ingredients. If a mixture contains more than one Group 2 protein-contributing ingredient, the label should also state the total percentage of protein in the mixture.

If there is reason to suspect that a particular shipment of cure mix, Group 2 protein-contributing ingredient, or mixture of Group 2 protein-contributing ingredients is not in compliance, the program employee should contact the Technical Service Center (TSC).

With the exception of anticaking agents, dry ice, artificial casings, and similar products, all nonmeat and nonpoultry items used as ingredients in meat or poultry products must be food grade types and identified by *one* of the following methods:

- Identified as "*food grade*" *or "food chemical codex*" on their container.
- Identified as having been prepared in a *USDA-approved* plant, or
- Accompanied by a supplier's *letter of guaranty.*

A supplier's letter of guaranty assures that proper food ingredients are used in meat and poultry products. An example would be: "(Name or person or company giving the guaranty) hereby guarantees that no article listed herein is adulterated or misbranded within the meaning of the Federal Food, Drug, and Cosmetic Act."

There are different types of letters of guaranty. A *limited* guaranty is for a specific shipment or delivery of an article. A *general or continuing* guaranty is for each shipment and any shipment thereafter made by the supplier. A continuing guaranty is sometimes referred to as a master continuing guaranty when a multi-establishment firm gives each establishment an updated list of suppliers.

Guarantees do not relieve the plant from its responsibility of examining ingredients to ensure they are wholesome and subjecting them to further cleaning, washing, or preparation according to good manufacturing practices.

If a *limited guaranty* is used, the FSIS program employee shall verify which ingredients are covered by that guaranty. If establishment management cannot produce a letter of guaranty for an additive, the inspection program employee will issue a noncompliance record (NR).

IDENTIFICATION REQUIREMENTS

In the meat and poultry industry today the purchase of premixed or preblended ingredients is common; however, many plants prepare their own mixture by combining the various ingredients as suited to their specific needs. Each ingredient must be properly labeled and any device used to measure ingredients must be accurate. In order to prevent the improper use of restricted ingredients, one of the following procedures must be followed unless an alternate procedure is approved:

- Each restricted ingredient is properly identified and individually weighed into separate containers in single batch formula amounts. This is the procedure most plants will use.
- If a mixture is prepared for a single batch formula containing both restricted and nonrestricted ingredients in the same container (excluding NFDM, cereal and soy products), each container must bear the following information:
  - The product name
  - Each ingredient listed in predominant order
  - The percent of each restricted ingredient
  - The net weight of the mixture and the total weight of the batch

Premixed or preblended additives/ingredients such as spices, flavorings, colors, seasoning mixtures, sauces, batters, or breadings are considered to be "proprietary" mixtures when the precise recipe is not generally disclosed to processors by the mixture's manufacturer. Such mixtures are under the jurisdiction of the Food and Drug Administration (FDA). FSIS's Proprietary Mix Committee (PMC) has evaluated proprietary mixtures as a voluntary service to the industries preparing these products to help assure that the products entering meat and poultry plants are appropriately labeled, and that finished meat or poultry products are accurately labeled to reflect the ingredients of the proprietary mixtures.

Proprietary mixtures may be used in inspected meat/poultry products *only* if the mixes' components can be listed appropriately on the label of the finished products. Therefore, inspected establish-ments using proprietary mixes must assure the mixes are labeled with or covered by a letter that includes:

- The name or code number of the proprietary mix and the name and address of the proprietary mix supplier; and

EITHER

- A complete listing of all ingredients, by common or usual name, with the percentage of each ingredient indicated;

OR

- A copy of an applicable PMC advisory letter that specifies:
  - All ingredients in the proprietary mix listed as required by FDA regulations, in order of predominance, by common or usual name (except those that still may be listed as "natural flavor," "natural flavoring," "flavor," or "flavoring.");
  - The percentage of all restricted ingredients and the protein content (total nitrogen x 6.25) of the mix on a wet weight basis when the mixture contains proteinaceous ingredients; and
  - A suggested list of ingredients that may be adapted for use by the inspected processor on its product labels showing the mix ingredients in order of predominance, by common or usual name (except those that still may be listed as "natural flavor," "natural flavoring," "flavor," or flavoring as they would appear in the meat or poultry product ingredient statement.

PMC advisory letters should accompany the shipments of "proprietary mixtures;" when received into the official establishment; however, PMC letters should not be used as the basis of allowing or disallowing proprietary mixes to enter the establishment. If the establishment cannot provide an explicit breakdown of the ingredients in the mix or a PMC letter is not provided, then the product would be misbranded and the inspection program employee may withhold production (i.e., use of the label) until the suitability of the ingredient mix and accuracy of the label is determined.

EXAMINING ADDITIVES

The FSIS program employee should *examine* nonmeat and nonpoultry ingredients by using sight, smell, and feel. With experience, i FSIS program employees can learn to detect changes in the texture, odor, or appearance of various ingredients, which could be cause to suspect substitution or adulteration. An FSIS program employee should be very cautious in tasting some ingredients as very small amounts could cause serious health problems and physical damage. Caution must also be taken when smelling the ingredients.

LABELING REQUIREMENTS FOR CERTAIN ADDITIVES

FSIS requirements for additives that may be designated as "spice," "natural flavor," "natural flavoring," "flavor," or "flavoring" in the list of ingredients on labels for meat and poultry products are:

- An additive that may be designated as a “spice” is one from any aromatic vegetable substance in the whole, broken, or ground form, with the exceptions of onions, garlic, and celery, the primary function of which in food is seasoning rather than nutritional and from which no portion of any volatile oil or other flavoring principle has been removed.
- An additive that may be designated as a “natural flavor,” “natural flavoring,” “flavor,” or “flavoring” is an essential oil, oleoresin, essence, or extractive, distillate, or any product of roasting or heating that contains the flavoring constituents of any spice, fruit or fruit juice, vegetable or vegetable juice, edible yeast, herb, bark, bud, root, leaf, or any other edible portion of a plant.
- An additive that is a natural spice, powdered onion, powdered garlic, or powdered celery may be designated as a “natural flavor,” “natural flavoring,” “flavor,” or “flavoring.”
- Additives of slaughtered livestock or poultry origin, as well as other additives such as plant products, animal products, egg products, dairy products, yeast products or their derivatives, which have been processed by hydrolysis, extraction, concentrating or drying, which primary function in the food is *nutritional* rather than flavoring, cannot be designated as “natural flavor, “natural flavoring,” “flavor,” or “flavoring.” These additives must be listed in the ingredients statement by their standard, common, or usual name. Hydrolyzed (plant) protein; hydrolyzed milk protein; hydrolyzed (meat) and (meat byproducts); autolyzed yeast; autolyzed yeast extract; lemon juice; and dried (species) stock, broth, and extract are some examples of additives that have been designated as flavors but now must be designated by their common and usual name. Those words shown in parentheses would need to be specified in the ingredient statement, e.g., hydrolyzed wheat protein, hydrolyzed beef, or hydrolyzed pork skin. (See FSIS Directive 7237.1, Rev. 1.)
- Any additive not designated in §317.2(f)(1) or §381.118(c) of the MPI regulations, the function of which is flavoring, either in whole or in part, such as monosodium glutamate, salt, corn syrup, etc., must be designated by its common and usual name.

RECEIVING PACKAGING MATERIALS INTO OFFICIAL ESTABLISHMENTS

The MPI regulations require official establishments to provide, and keep on file, a written guaranty or statement of assurance for all materials that come in contact with product, or that may become components of food because of their contact with meat or poultry food products.

These are points that the FSIS program employee should look for in the guaranty.

- It must be from the supplier of the packaging material. Acceptance letters issued by FSIS are not acceptable substitutes.
- The listed firm and brand names must be traceable to the material that it covers.
- It may come from within the plant itself, i.e., a coating applied to material used within the plant to form different sizes and/or shapes of trays, etc.

The format of the guaranty should have:

- A statement indicating the material complies with the Federal Food, Drug, and Cosmetic Act (FFDCA) and any applicable regulations.

- A brand name or code designation of the material. (The code may be any combination of letters or numbers that is used by the supplier to identify a specific packaging material.)
- The name of the supplier.
- Conditions for use of the material and any limits to its use (e.g., temperature) that must be observed in order for the guaranty to be valid.
- The signature of an official of the supplier. (The signing official need not be an officer of the supplying firm, but the signature should be followed by his/her printed name and title.)

There are two basic types of acceptable guarantees:

- *Limited,* where the guaranty is limited to a specific shipment of an article(s). In this example the guaranty may be a part of, or attached to, the invoice covering such shipment.
- *General or continuing,* where the guaranty is applied to an article or other shipment of an article, it is considered to have been given on the date that the articles were shipped by the person giving the guaranty.

SUPPLEMENT

RESOURCES: 1. Meat and Poultry Inspection Regulations
2. FSIS Directive 7620.3--Processing Inspectors' Calculations Handbook

Additives Worksheet Exercise

With the help of the Meat and Poultry Inspection Regulations and FSIS Directives, answer the following questions. References are given as an aid in locating the correct answer.

1. One or more of the following binders may be used in cooked sausage: dried milk, calcium-reduced dried skim milk, nonfat dry milk, cereal, vegetable starch, starchy vegetable flour, soy flour, soy protein concentrate, and isolated soy protein. [R318.7(c)(4); FSIS Directive 7620.3]

   a. What percent individually or collectively is allowed?

   b. On what part of the formula is the percent based?

   c. How much isolated soy protein is equivalent to the maximum amount of other binders?

2. The two types of guarantees for packaging materials are: [R317.24]

   a.

   b.

3. List a fresh meat product in which paprika may be used: [R318.7(d)(1)]

4. When sorbitol is used in a cooked sausage product: [R318.7(c)(4); FSIS Directive 7620.3]

   a. What percent is allowed?

   b. On what part of the formula is the percent based?

_____

_____

c. Sorbitol contains _____% solids and _____% water.

5. Given the following additives, identify their purpose, the products to which they can be added, and the amount allowed. [R318.7(c)(4); R381.147(f)(4)]

a. Disodium phosphate

Purpose _____

Products _____

_____

_____

Amount allowed _____

_____

b. Calcium lactate (when not used as a binder/extender)

Purpose _____

Products _____

_____

_____

Amount allowed _____

c. Algin

Purpose _____

Products _____

_____

_____

Amount allowed _____

d. Radiation

Purpose _____

_____

Products _____

_____

_____

_____

Amount allowed _____

_____

_____

_____

_____

Calculations for Restricted Ingredients

This part of the supplement will cover mathematical calculations to determine compliance for the following additives:

- Curing agents and curing compounds,
- Curing accelerators, and
- Antioxidants

Inspection program employees may use two methods to determine curing agent, curing compound or curing accelerator compliance. They can determine the in-going parts per million of the cure agent or accelerator used in the formula and then compare their result against the in-going amount allowed by the MPI regulations. If the calculated in-going amount is equal to or less than the amount allowed by regulation, the product is in compliance. Alternatively, they could determine the maximum amount of the cure agent, cure compound, or cure accelerator allowed in the formula and then compare their calculated result to the amount that is actually being used in the formula. If the amount used in the formula is equal to or less than the maximum amount allowed, the product is in compliance.

Note: For purposes of these supplement problems, an answer to 2 decimal points will be acceptable!

(Do not round up when calculating restricted ingredient amounts.)

I. CURING AGENT (NITRITE AND NITRATE) AND COMPOUND CALCULATIONS

Introduction

Calculations for curing agents are based on the ***green weight of the meat and/or poultry and/or meat/poultry byproducts (meat block),*** used in the formulation of the product. Because nitrite and nitrate, after being converted to nitric oxide, function by reacting chemically with the meat or poultry myoglobin, the amounts of nitrite or nitrate permitted in the cure must be based on the meat block used in the formulation, ***not*** the finished weight of the product. Using finished weight as the weight base for these calculations would be unacceptable because more curing agent than is allowed could be added to the product. Excess nitrite or nitrate can be toxic.

Either the sodium or the potassium salt of nitrite may be used for curing products, but the weight limitation (based on sodium) is the same for both salts. This limitation was established when the sodium salt was the only one permitted. Later, the use of the potassium salt was allowed at the same level. This level is safe, but rather conservative because potassium is a heavier element than sodium and a greater weight of a potassium salt must be used for the equivalent amount of nitrite or nitrate to be in the product. The bacon regulation, which is more recent than those governing other cured products, also permits both salts, but at different limits for each salt.

As a matter of policy, the Agency requires a ***minimum*** of 120 ppm of in-going nitrite in ***all*** cured "Keep Refrigerated" products, unless the establishment can demonstrate that safety is assured by some other preservation process, such as thermal processing, pH or moisture control. This 120 ppm policy for in-going nitrite is based on safety data reviewed when the bacon standard was developed.

There ***is no*** regulatory *minimum* in-going nitrite level for cured products that have been processed to ensure their shelf stability (such as having undergone a complete thermal process, or having been subjected to adequate pH controls, and/or moisture controls in combination with appropriate packaging). However, 40 ppm nitrite is useful in that it has some preservative effect. This amount has also been shown to be sufficient for color-fixing purposes and to achieve the expected cured meat or poultry appearance. Some thermally processed shelf-stable (canned) products have a minimum in-going nitrite level that must be verified because it is specified as a critical factor in the product's process schedule or as a critical limit in the HACCP plan.

Nitrate is used as a source of nitrite. If nitrate is used as the curing agent, it must be converted (reduced) to nitrite by bacteria in the meat or poultry. This is a necessary step in the development of the cured color. The amount of nitrate that is reduced to nitrite is dependent upon the numbers of nitrate-reducing bacteria and several environmental conditions such as temperature, moisture content, salt content, and pH. Hence, the conversion rate and subsequent amount of nitrite that is formed is difficult to control. Similarly, the further reduction of nitrite to nitric oxide, which reacts with myoglobin (muscle pigment) to produce the cured color, is also affected by the same environmental conditions. If nitrite is used as the curing agent, there is no need for the nitrate reduction

step, and the development of the cured color is much more rapid.

The poor control associated with the reduction of nitrate to nitrite, coupled with the fact that most processors today demand faster curing methods, has lead to the diminished use of nitrate in meat and poultry products.

Limits for restricted ingredients (RI) permitted in meat and poultry products are expressed in terms of ounces (oz) or pounds (lb) per pounds of the meat/poultry or gallons of pickle solution, or as percentages (%) in the Tables of Approved Substances in sections 318.7(c)(4) and 381.147(f)(4) of the MPI Regulations. The same limits may be expressed in parts per million (ppm) which are more convenient units for verifying food additive compliance. The conversion of curing agent weight limits to parts per million (ppm) limits is shown in Table I.

TABLE 1

Nitrite Limits in Regulations	**Converted to Maximum PPM Limit**
	General PPM Formula for Pickled Product: **ppm = $\frac{\text{lb RI} \times \text{\% pump} \times 1{,}000{,}000}{\text{lb of pickle}}$**
2 lb to 100 gallons of pickle at 10% pump	If 1 gallon pickle weighs 10 lb (wt. base when regulations were written), then 100 gallons weighs 1000 lb. $\frac{2 \text{ lb} \times .10\ (10\%) \times 1{,}000{,}000}{1000 \text{ lb}} = 200$ ppm
	General PPM Formula for Dry Cured Product: **ppm = $\frac{\text{lb RI} \times 1{,}000{,}000}{\text{lb meat or poultry}}$**
1 oz to 100 lb meat or poultry product (dry cure)	1 oz = 1 ÷ 16 = 0.0625 lb $\frac{0.0625 \text{ lb} \times 1{,}000{,}000}{100 \text{ lb}} = 625$ ppm

TABLE 1

Nitrite (Continued)	**General Formula for Comminuted Product is the same as Dry Cured Product**
1/4 oz to 100 lb of chopped meat and/or meat byproduct and/or poultry product	1/4 oz = .25 ÷ 16 = 0.015625 lb $\frac{0.015625 \text{ lb} \times 1{,}000{,}000}{100 \text{ lb of meat/poultry}}$ = 156.25 or 156 ppm
Nitrate Limits in the Regulations	**Converted to Maximum PPM Limit** **All of the General Formulas for nitrite are the same for nitrate conversions.**
7 lb to 100 gallons of pickle at 10% pump	$\frac{7 \text{ lb} \times .10\ (10\%) \times 1{,}000{,}000}{1000 \text{ lb}}$ = 700 ppm
3 1/2 oz to 100 lb meat or poultry product (dry cure)	3 1/2 oz = 3.5 ÷ 16 = 0.21875 lb $\frac{0.21875 \text{ lb} \times 1{,}000{,}000}{100 \text{ lb}}$ = 2,187.5 or 2,187 ppm
2 3/4 oz to 100 lb chopped meat and/or meat byproduct and/or poultry product	2 3/4 oz = 2.75 ÷ 16 = 0.171875 lb $\frac{0.171875 \text{ lb} \times 1{,}000{,}000}{100 \text{ lb meat/poultry}}$ = 1,718.75 or 1,718 ppm

In-going Curing Agent PPM Determinations

The amount of in-going cure agent permitted in comminuted products, such as bologna, specific and nonspecific loaves, salami, etc., is based on the green weight of the meat and/or poultry and/or meat/poultry byproducts (meat block) used in the product formulation. The regulatory limit for in-going nitrite is 156 ppm or less, and for nitrate it is 1,718 ppm or less.

Curing Agent Added Individually

FORMULA: $\frac{\text{lb of cure agent} \times 1{,}000{,}000}{\text{lb of meat block}} = \text{in-going ppm}$

SAMPLE PROBLEM #1: A bologna formula contains *325 pounds* of meat and meat byproducts and *¾ ounce* of nitrite. What is the amount of in-going nitrite?

To determine the in-going level of nitrite, convert the ounces of nitrite to pounds, then plug the known weights into the formula and calculate.

Step 1: .75 oz ÷ 16 = 0.0468 lb nitrite

Step 2: $\frac{0.0468 \text{ lb} \times 1{,}000{,}000}{325 \text{ lb}}$ = 144 ppm in-going nitrite

Since 144 ppm is less than the 156 ppm regulatory limit for nitrite, this formula is in compliance.

SAMPLE PROBLEM #2: An Old Fashioned Pepper loaf formula contains *375 pounds* of meat and meat byproducts and *12 ounces* of nitrate. What is the amount of in-going nitrate?

To determine the in-going level of nitrate, convert the ounces of nitrate to pounds, then plug the known weights into the formula and calculate.

Step 1: 12 oz ÷ 16 = 0.75 lb nitrate

Step 2: $\frac{0.75 \text{ lb} \times 1{,}000{,}000}{375 \text{ lb}}$ = 2,000 ppm in-going nitrate

Since 2,000 ppm is more than the 1,718 ppm regulatory limit for nitrate, this formula is **NOT** in compliance.

Curing Agent Added to the Formula in a Curing Compound or Mix

Remember that the percentage of nitrite and/or nitrate must be indicated on the compound or mix container. To determine the in-going ppm of the cure agent, the formula must be altered to include the cure agent's percentage in the mix.

FORMULA: $\frac{\text{lb of cure mix} \times \text{\% of cure agent in mix} \times 1{,}000{,}000}{\text{lb of meat block}}$ = in-going ppm

SAMPLE PROBLEM: A wiener formula contains *500 pounds* of meat, poultry, and meat byproducts and *1 pound* of cure mix containing 8% nitrite. What is the amount of in-going nitrite?

To determine the in-going level of nitrite, plug the known values into the formula and calculate.

$$\frac{1 \text{ lb} \times 0.08\ (8\%) \times 1{,}000{,}000}{500 \text{ lb}} = 160 \text{ ppm in-going nitrite}$$

Since 160 ppm is more than the 156 ppm regulatory limit for nitrite, this formula is **NOT** in compliance.

Maximum Curing Agent and Curing Compound Determinations

The amount of nitrite permitted for use in cured comminuted meat or poultry food products is ¼ *ounce* for every 100 pounds of meat, poultry, meat byproducts, or poultry byproducts (meat block) in the formula. The amount of nitrate permitted for use in cured comminuted meat or poultry food products is 2¾ *ounce* for every 100 pounds of meat, poultry, meat byproducts, or poultry byproducts (meat block) in the formula.

Maximum Cure Agent Allowed

FORMULA: $\left(\frac{\text{lb of meat block}}{100 \text{ lb}}\right)$ × restricted level/100 lb meat block = maximum amount of cure agent allowed

SAMPLE PROBLEM #1: A cotto salami formula contains *400 pounds* of meat, meat byproducts and poultry. What is the maximum amount of nitrite allowed this formula?

To determine the maximum amount of nitrite allowed, plug the known values into the formula and calculate.

$$\left(\frac{400 \text{ lb meat block}}{100 \text{ lb}}\right) \times .25 \text{ oz} = 1.00 \text{ oz of nitrite allowed}$$

If more than 1.00 oz of nitrite was added to the cotto salami formulation, the product would be out of compliance.

SAMPLE PROBLEM #2: A pepperoni formula contains *200 pounds* of meat. What is the maximum amount of nitrate allowed in this formula?

To determine the maximum amount of nitrate allowed, plug the known values into the formula and calculate.

$$\left(\frac{200 \text{ lb meat block}}{100 \text{ lb}}\right) \times 2.75 \text{ oz} = 5.5 \text{ oz of nitrate allowed}$$

If more than 5.5 oz of nitrate was added to the pepperoni formulation, the product would be out of compliance.

Maximum Cure Compound or Mix Allowed

To determine the maximum amount of cure mix allowed in a formula, you must first calculate how much curing agent is allowed by using the formula and calculation previously demonstrated. Once the maximum amount of cure agent allowed has been determined, use the following formula to determine the maximum amount of curing mix/compound allowed.

FORMULA:

Amount of cure agent allowed ÷ % of cure agent in the mix = Maximum amount of curing mix allowed

SAMPLE PROBLEM #1: A bologna formula contains *350 pounds* of meat and meat byproducts. How much curing mix containing *6.25% nitrite* would be allowed?

Step 1: $\frac{\text{350 lb meat block}}{\text{100 lb}} \times$ .25 oz (1/4 oz) = 0.875 oz maximum nitrite allowed

Step 2: 0.875 oz nitrite allowed ÷ 0.0625 (6.25%) = 14 oz maximum cure mix allowed

If more than 14 oz of curing mix was added to the bologna formulation, the product would be out of compliance.

SAMPLE PROBLEM #2: A summer sausage formula contains *600 pounds* of meat and meat by products. How much curing compound containing *12% nitrate* would be allowed?

Step 1: $\frac{\text{600 lb meat block}}{\text{100 lb}} \times$ 2.75 oz = 16.5 oz maximum nitrate allowed

Step 2: 16.5 oz nitrate allowed ÷ 0.12 (12%) = 137.5 oz or 8.59 lb maximum cure mix allowed

If more than 137.5 oz (or 8.59 lb) of curing mix was added to the summer sausage formulation, the product would be out of compliance.

Note: If nitrate is used in conjunction with nitrite in the preparation of a comminuted product, the limits of the two ingredients are calculated separately and the permitted maximum (weight or ppm) of each may be used.

Work the following problems

1. A knockwurst formula contains *600 pounds* of meat and meat byproducts. Determine the maximum amount of nitrite **and** nitrate permitted in this formula.

2. A polish sausage formula contains *460 pounds* of meat and *1.25 ounces* of nitrite. What are the in-going ppm of nitrite? Is this formula in compliance?

3. A liverwurst formula contains *500 pounds* of meat and meat byproducts. How much *curing compound* containing *8% nitrite* would be allowed?

4. A frankfurter formula contains *700 pounds* of meat, poultry, and meat byproducts and *26 ounces* of cure mix containing *6.25% nitrite*. What are the in-going ppm of nitrite? Is this formula in compliance?

5. A pepperoni formula contains *200 pounds* of meat and *5 ounces* of nitrate. What are the in-going ppm of nitrate? Is this formula in compliance?

II. CURING ACCELERATORS CALCULATIONS

Introduction

Cure accelerators speed up the cure color development (color fixing) by accelerating the chemical conversion of nitrous acid to nitric oxide. In addition, cure accelerators aid in keeping myoglobin (the muscle pigment) in the reduced state so that it can readily combine with nitric oxide to form nitric oxide myoglobin. During heating, nitric oxide myoglobin is converted to nitrosohemochromogen, which is responsible for the bright pink color characteristic of cured meat. **Since cure accelerators aid the curing agents, i.e., nitrite and nitrate, in cure color development they may only be used in combination with the curing agents.**

The amounts of curing accelerators are calculated on the basis of the ***green weight of the meat and/or poultry and/or meat/poultry byproducts (meat block)*** in the formulation and are controlled on an in-going basis. ***The formulae and methods for calculating nitrite and nitrate amounts also apply in the calculation of cure accelerator in-going ppm and maximum amounts.*** Different regulatory limits apply, depending upon which cure accelerator is used.

The limits for curing accelerators permitted in meat and poultry products are also expressed in terms of ounces (oz) or pounds (lb) per pounds of the meat/poultry or gallons of pickle solution, or as percentages (%) in the MPI Regulations. The same limits may be expressed in parts per million (ppm). The conversion of curing accelerator weight limits to parts per million (ppm) limits is shown in Table II.

TABLE II

Cure Accelerators in Regulations	**Converted to Maximum PPM Limit**
Ascorbic Acid and Erythorbic Acid	**Conversion formulae are the same as those for the curing agents.**
	If 1 gallon pickle weighs 10 lb (wt. base for regulations), then 100 gallons weighs 1000 lb.
75 oz to 100 gal pickle at 10% pump	75 oz = 75 ÷ 16 = 4.687 lb $\frac{4.687 \text{ lb} \times 0.10 \times 1{,}000{,}000}{1000 \text{ lb}}$ = 468.7 or 469 ppm
3/4 oz to 100 lb meat or meat byproduct or poultry product	3/4 oz = .75 ÷ 16 = .04687 lb $\frac{.04687 \text{ lb} \times 1{,}000{,}000}{100 \text{ lb}}$ = 468.7 or 469 ppm

TABLE II

Ascorbate and Erythorbate 87.5 oz to 100 gal pickle at 10% pump 7/8 oz to 100 lb meat or meat byproduct or poultry product	**Converted to Maximum PPM Limit** 87.5 oz = 87.5 ÷ 16 = 5.468 lb $\frac{5.468 \text{ lb} \times 0.10 \times 1{,}000{,}000}{1000 \text{ lb}}$ = 546.8 or 547 ppm 7/8 oz = .875 ÷ 16 = 0.0547 lb $\frac{0.0547 \text{ lb} \times 1{,}000{,}000}{100 \text{ lb}}$ = 547 ppm
Glucono delta-lactone (GDL) 8 oz to 100 lb meat or meat byproducts 16 oz (1 lb) to 100 lb of meat (1%) (Genoa salami only) ***GDL is allowed only in cured comminuted MEAT products***	**Converted to Maximum PPM Limit** 8 oz = 8 ÷ 16 = 0.5 lb $\frac{0.5 \text{ lb} \times 1{,}000{,}000}{100 \text{ lb}}$ = 5,000 ppm 16 oz = 1 lb $\frac{1 \text{ lb} \times 1{,}000{,}000}{100 \text{ lb}}$ = 10,000 ppm
Sodium Acid Pyrophosphate (SAPP) 8 oz in 100 lb meat or meat and meat byproducts ***SAPP is allowed only in cured comminuted MEAT products***	**Converted to Maximum PPM Limit** 8 oz = 8 ÷ 16 = 0.5 lb $\frac{0.5 \text{ lb} \times 1{,}000{,}000}{100 \text{ lb}}$ = 5,000 ppm (5000 ppm = 0.005 = 0.5%) ***SAPP is limited 5,000 ppm either alone or in combination with other curing accelerators. For example, if a formula had 500 ppm in-going erythorbate, then only 4,500 ppm in-going SAPP would be allowed in the formula.***

In-going Curing Accelerator PPM Determinations

The amount of in-going cure accelerator used in comminuted products, such as bologna, specific and nonspecific loaves, salami, etc., is based on the green weight of the meat and/or poultry and/or meat/poultry byproducts (meat block) used in the product formulation.

FORMULA: $\frac{\text{lb of cure accelerator} \times 1{,}000{,}000}{\text{lb of meat block}} = \text{in-going ppm}$

SAMPLE PROBLEM: A bologna formula contains *325 pounds* of meat and meat byproducts and 2.5 *ounces* of sodium erythorbate. What are the in-going ppm of sodium erythorbate?

To determine the in-going level of sodium erythorbate, convert the ounces of sodium erythorbate to pounds, then plug the known weights into the formula and calculate.

Step 1: 2.5 oz ÷ 16 = 0.15625 lb sodium erythorbate

Step 2: $\frac{0.15625 \text{ lb} \times 1{,}000{,}000}{325 \text{ lb}} = 480.76$ ppm in-going sodium erythorbate

Since 480.76 ppm is less than the 547 ppm regulatory limit for sodium erythorbate, this formula is in compliance.

Maximum Curing Accelerator Determinations

The following is a list of common curing accelerators and the maximum amount allowed for *each 100 lb of meat, meat byproducts, poultry, and poultry byproducts (meat block) in the formula.*

- Ascorbic Acid and Erythorbic acid—3/4 oz
- Sodium Ascorbate and Sodium Erythorbate—7/8 oz
- Glucono delta lactone and sodium acid pyrophosphate—8 oz (allowed only in products that carry the meat inspection legend). Sodium acid pyrophosphate limited to 8 oz alone or in combination with other curing accelerators.

FORMULA: $\left(\frac{\text{lb of meat block}}{100 \text{ lb}}\right) \times \text{restricted level/100 lb meat block} = \text{max. amount of cure accelerator allowed}$

SAMPLE PROBLEM: A cotto salami formula contains *400 pounds* of meat, meat byproducts and poultry. What is the maximum amount of ascorbic acid allowed this formula?

To determine the maximum amount of ascorbic acid allowed, plug the known values into the formula and calculate.

$$\left(\frac{\text{400 lb meat block}}{\text{100 lb}}\right) \times .75 \text{ oz } (3/4 \text{ oz}) = 3.00 \text{ oz of ascorbic acid allowed}$$

If more than 3.00 oz of ascorbic acid was added to the cotto salami formulation, the product would be out of compliance.

Work the following problems

1. A pickle and pimento loaf formula contains *450 pounds* of meat and meat byproducts. Determine the maximum amount of erythorbic acid and glucono delta lactone permitted in this formula.

2. A poultry frankfurter formula contains *700 pounds* of poultry meat and *8 ounces* of sodium erythorbate. What are the in-going ppm of sodium erythorbate? Is this formula in compliance?

3. A wiener formula contains *400 pounds* of meat, poultry, and meat byproducts and *3 ounces* of ascorbic acid and *32 ounces* of sodium acid pyrophosphate. What are the in-going ppm of ascorbic acid and sodium acid pyrophosphate? Is this formula in compliance?

III. ANTIOXIDANT CALCULATIONS

Oxidative rancidity occurs when the double bonds of polyunsaturated meat and poultry fats are exposed to oxygen present in air, and undergo oxidation (breakdown) to form aldehydes, acids, and ketones. This results in the development of off-odors and flavors in the product. Antioxidants are chemicals that react with oxygen before it can react with the double bonds of polyunsaturated meat or poultry fats, and therefore retard oxidative rancidity. For animal fats, animal/vegetable fats, dry sausage, and dried meats, the amount of antioxidants used is based on the entire weight of the product. When antioxidants are added to products such as pork sausage, brown-and-serve sausage, Italian sausage, etc., the amount is based on the fat content of the product. A synergist such as citric acid may be used with antioxidants to increase their effectiveness.

Limitations for antioxidants and synergist in lard

- Individual antioxidants (0.01% of total weight)
- Antioxidants in combination (0.02% of total weight)
- Synergist (0.01% of total weight)
- *Limitations for antioxidants and synergist in fresh sausage*
- Individual antioxidants (0.01% of fat content), except tocopherols
- Tocopherols (0.03% of fat content). They cannot be used in combination with other antioxidants.
- Antioxidants in combination (0.02% of fat content)
- Synergist (0.01% of fat content)

Most antioxidants used will be in a mix or compound containing a carrier, two or more individual antioxidants, and possibly a synergist. It will not be necessary to calculate for each antioxidant or synergist. One calculation will be sufficient if the following rules are applied.

- If *no* individual antioxidant or synergist is more than half of the total antioxidants in the mix. (Calculate for the total of all antioxidants in combination using 0.02%)
- If *one* individual antioxidant or synergist is more than half the total antioxidants in the mix. (Calculate for that individual antioxidant or synergist 0.01%.)

- If *one* individual antioxidant or synergist is exactly half (50%) of the total antioxidants in the mix. (Calculate for either that individual antioxidant or synergist at 0.01% *or* for the total of all antioxidants in combination at 0.02%. The result will be the same.)

To determine the maximum amount of an antioxidant mix allowed in lard, rendered animal fats, or rendered animal/vegetable fats, let's look at some examples.

Example 1

An establishment has a barrel of antioxidant compound stored in the dry storage area that has the following ingredients and their percentages listed on the label: butylated hydroxyanisole (BHA)-30%, butylated hydroxytoluene (BHT)-10%, glycine-7%, propyl gallate-5%, citric acid-5%, and carrier-43%. How much of this antioxidant mix can be added to 10,000 lb of lard?

- Step 1. Determine the amount of product to which the antioxidant compound is to be added. In this example, the amount of product is 10,000 lb of lard.

- Step 2. Determine the total content of the antioxidant/synergist mixture and the percentage of each ingredient. This information will be listed on the label of the antioxidant mixture container. (See percentages above.)

- Step 3. Determine what percentage of the mixture is made up of antioxidants. In other words, total the percentages of antioxidants in the mix. For this example:

BHA	30%
BHT	10%
Glycine	7%
Propyl Gallate	5%
	52% total

- Step 4. If any one of the antioxidants or synergist makes up more than half of the antioxidant total, multiply the product weight by 0.0001 (0.01%) to determine the amount of antioxidant allowed. If no single antioxidant or synergist makes up more than half (26%) of the antioxidant total, multiply the product weight by 0.0002 (0.02%) to determine the amount of antioxidant allowed. Since BHA (30%) is more than half (26%) of the antioxidant total (52%) you would multiply the product weight by 0.0001 (0.01%) to determine the amount of antioxidant mix allowed *or* 10,000 lb. x 0.0001 = 1.0 lb (16 oz) for this example.

- Step 5. If one individual antioxidant or synergist makes up more than half of the antioxidant total, divide the amount of antioxidant allowed (from Step 4) by the percent of the *major* antioxidant or synergist to determine the amount of antioxidant compound

that can be used. If no individual antioxidant or synergist makes up more than half of the antioxidant total, divide the amount of antioxidant allowed (from Step 4) by the percentage of *total* antioxidants to determine the amount of antioxidant compound that can be used. In this example, BHA (30%) makes up more than half (26%) of the total antioxidants; therefore, you would divide the amount of antioxidant allowed (from Step 4) by the percentage of the major antioxidant in the mix, in this case BHA, to determine the amount of antioxidant compound that can be used.

1.0 lb (amount of antioxidant allowed) ÷ .30 (30%-BHA, which is the major antioxidant in the mix) = 3.33 lb (maximum amount of antioxidant compound allowed)

In this example, the plant could add a maximum of 3.3 lb of this antioxidant compound to 10,000 lb of lard.

Example 2

The same establishment has the same amount of product as in the previous example (10,000 lb of lard). However, instead of using the same antioxidant compound, the plant uses another antioxidant compound that has the following ingredients and their percentages listed on the label: BHA-20%; BHT-10%; glycine -10%; propyl gallate -5%; citric acid-5%; and carrier-50%. How much of this antioxidant mix can be added?

Apply Step 1-5 as in previous example.

In this example, the total percentage of antioxidants in the mix is:

BHA	20%
BHT	10%
Glycine	10%
Propyl gallate	5%
	45%

Since no single antioxidant or synergist makes up half (22.5%) of the antioxidant total (45%), multiply the product weight by 0.0002 (0.02%) to determine the amount of antioxidant allowed (see Step 4 in previous example).

10,000 lb (amount of product) x 0.0002 = 2.0 lb (amount of antioxidant allowed)

No single antioxidant or synergist makes up more than half of the antioxidant total; therefore, divide the amount of antioxidant allowed by the percentage of total antioxidants to determine the amount of antioxidant compound that can be used (see Step 5 in previous example).

2.0 lb (amount of antioxidant allowed) ÷ 0.45 (45% or total percentage of antioxidants in the mix) = 4.44 lb (maximum amount of antioxidant compound allowed)

In this example, the plant could add a maximum of 4.44 lb of this antioxidant compound to 10,000 lb of lard.

To determine the maximum amount of a single *antioxidant* allowed in fresh sausage or other fresh products, look at the following example:

Example 3

If an establishment formulates a 650 lb batch of fresh pork sausage with a fat content of 35% (determined by rapid fat analysis and/or via formulation), how much butylated hydroxyanisole (BHA) can be used?

- Step 1. Determine the weight represented by the fat content. In this example, 650 lb represents the total weight and of this 650 lb, 35% is fat, so:

  650 lb (total weight) x 0.35 (35%-percentage of fat content) = 227.5 lb (weight of the fat content)

- Step 2. Multiply the weight of the fat content by the antioxidant allowance to determine the amount of antioxidant that can be used. From Step 1, you know the weight of the fat content, and the antioxidant allowance for an individual antioxidant such as butylated hydroxyanisole is 0.01%; therefore, in this example:

  227.5 lb (weight of the fat content) x 0.0001 (0.01%-antioxidant allowance) = 0.02275 lb (maximum amount of BHA that can be used.)

  In this batch the plant could use a maximum of 0.02275 lb (0.36 oz) of BHA.

To determine the maximum amount of an *antioxidant compound* allowed in fresh sausage or other fresh products, proceed as follows:

- Apply Step 1 of Example 3. Remember that the base of control for antioxidant use in fresh sausage and other fresh products is the weight of the fat content of the product rather than the total weight of the product.

- Apply Steps 1—5 as if you were determining the maximum amount of an antioxidant compound allowed in lard or rendered animal fat. (See Example 1.)

Review the preceding examples before you calculate the following problems.

Work the following problems

1. Establishment 38 has 2,000 lb of rendered animal fat to which management intends to add an antioxidant compound that has the following ingredients and their percentages listed on the label: citric acid-35%, BHA-10%, BHT-10%, glycine-5%, and carrier-40%. How much of this antioxidant compound can be used?

2. Establishment 38 formulates an 875 lb batch of fresh Italian sausage with a fat content of 25% (determined by rapid fat analysis). How much tertiary butylhydroquinone (TBHQ) can be used?

3. Establishment 38 is formulating a 1240 lb batch of raw meatballs with a fat content of 40% (determined by rapid fat analysis). The formula calls for 0.34 lb (5.44 oz) of an antioxidant compound that has the following ingredients and their percentages listed on the label: BHA-25%, BHT-20%, propyl gallate-10%, citric acid-10%, and carrier-35%.

   What is the maximum amount of antioxidant compound allowed in this formula?

   _____

   Is the amount of antioxidant compound used in this batch in compliance?